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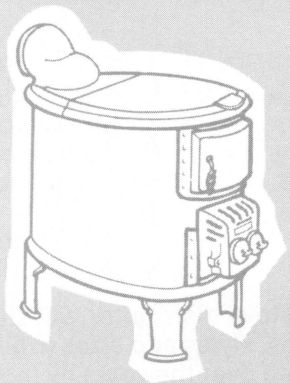
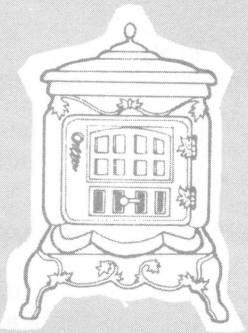
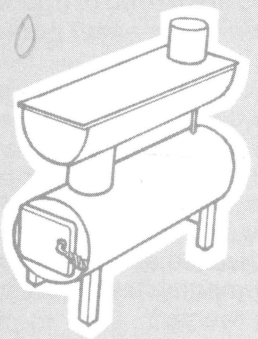
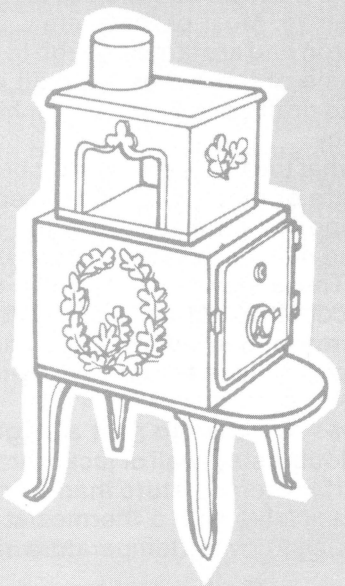
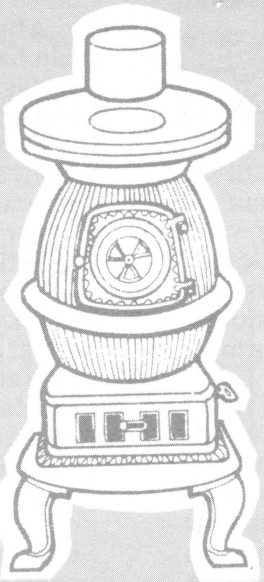


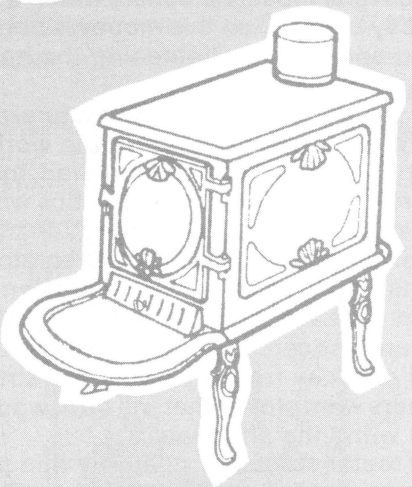


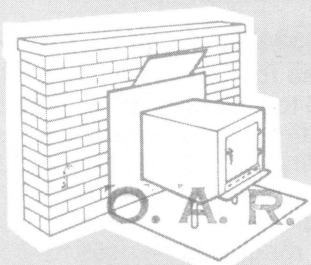


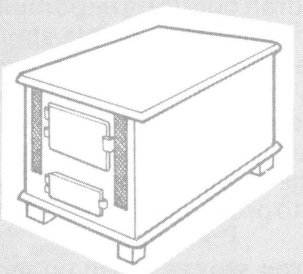
# STOVES

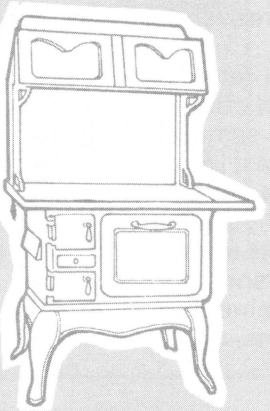












COOPERATIVE EXTENSION SERVICE
THE OHIO STATE UNIVERSITY

# STOVES

By Roger A. Miller
Extension Agricultural Engineer

Before purchasing a stove, first decide how it will be used. Will it be for:

- emergencies such as power outages?
- supplemental heat to the main furnace or to heat one or two rooms?
- total heating of the entire house?
- conversation and occasional use?

Consider the total cost of installing a stove. Remember you may need to buy stove pipe, floor and wall protection and a chimney. A complete installation can cost several thousand dollars which will take many years to pay back. Often this money is better spent on insulating and weather tightening the house before switching fuels.

There are thousands of manufacturers of woodburning stoves throughout the world. Appearance, style, finish, construction, materials, and weight are some of the characteristics which need to be evaluated. Durability of welding, sharpness of cabinet or stove edges which may scratch or cut people, and ability to burn wood efficiently for maximum heat are other factors to consider. Some persons are concerned with creosoting of the stove pipe and chimney from slow burning airtight stoves while others want stoves that will burn wood for a long time and with little attention.

**Sheet metal stoves** of relatively thin gauge have been used for many years for heating. They are inexpensive but have a shorter life than plate steel or cast iron stoves. They will quickly heat a room, but they also cool rapidly when the fire dies down. If occasional quick heating is needed, such as for a cabin, a garage, or emergency use, thin-walled stoves are appropriate.

Good draft control is important to control the rate of heating. Thin-walled stoves should never be heated red hot as they tend to warp and burn through. Examine these stoves frequently for thin spots.

**Plate steel stoves** made from steel ⅛ inch thick or thicker are also available. These welded stoves hold heat longer. Many of these stoves are lined with firebrick to protect the metal and to provide more even heat.

**Cast iron stoves** warm up more slowly and retain heat longer than sheet metal stoves. However, if other design and operating practices are equal, the same amount of heat will be delivered to the room. Cast iron holds up well under heat, has a long life, spreads the heat away from hot spots in the fire, and generally does not warp. It cracks easily if dropped. Used cast iron stoves should be thoroughly inspected by persons knowledgeable in their construction to determine if there are any cracked, broken, or missing parts, or areas that are warped or thin.

## Stove Types

A trip to a local stove distributor will show you that there are many types, styles and sizes available. These have been developed over the years by manufacturers to meet a particular purpose.

The **combination type stove** is similar to the Franklin stove in its use. It can be operated as an open fireplace or a closed stove. Most of these are manufactured of cast iron and are large enough to heat one or two rooms. Some of the stoves are built with airtight doors and good draft control and can achieve 50-60 percent efficiency.

A **box stove** is just what the name indicates, a box. It can have either a square or rectangular cross-section and is most often supported on legs. The wood is placed on a bed of sand or ashes as the stove does not usually have a grate. These stoves are available in many sizes, in airtight construction, and with baffles or warming boxes to increase their efficiency. In the larger sizes, the fire box will take firewood in 24-inch lengths.

The **parlor stove** was designed to heat a single room. It usually has a double steel wall or jacket around it that gives a lower surface temperature than a single wall stove. It is often available with a thermostat that regulates the drafts and thereby the temperature in the room.

The **pot belly stove** is most often associated with railroad stations and country houses. It is usually made of cast iron and often has ornate designs and trim. The small diameter firebox requires that wood be cut in short lengths. The added height allows better burning of the volatile gases.

**Fireplace stove:** Several stoves have been developed to increase the efficiency of the fireplace. The stove is attached to a piece of sheet metal that fits over the face of the fireplace. This makes a simple installation that eliminates the need for another chimney. Usually these stoves have a built-in damper, so the fireplace damper can remain open all the time.

**Kitchen stoves:** A range can be used for cooking as well as heating. Of course, a range warms the kitchen whenever it is used, which can be uncomfortable in summer. Most ranges are of cast iron construction and will burn either wood or coal. When wood is burned, the pieces need to be short and split fairly small.

**Circulating stoves:** Most stoves transfer heat to the room by radiating heat from the hot surface of the stove. A few manufacturers provide a double wall stove with air vents in the top and bottom of the outer wall. Air circulates between the wall of the stove by natural movement. Much of the heat produced by the stove is

transferred to the room by the heated air. The outer surface of a circulating stove is not as hot as a radiant stove.

## Efficiency

The stove characteristic that usually receives the most attention is efficiency. Efficiency is the percentage or fraction of chemical energy available from the wood that heats the room. Efficiency depends on:

- the wood used
- the skill of the operator
- the design of the stove and chimney.

Wood varies in size, density, and moisture content; it is not a simple, uniform fuel like natural gas, propane or fuel oil. Gas and oil burners uniformly mix fuel with oxygen while various size chunks of wood are periodically dumped into a firebox. Over the years many stove designs have been developed to overcome the difficulties inherent in wood-fueled combustion.

Wood-fueled heaters operate most efficiently when they are burning at nearly full capacity. In spring and fall it is difficult to operate wood stoves at full output to create high enough temperatures for good combustion and heat transfer without overheating the room. Gas and oil can be burned at fairly high efficiencies because the burner still operates at full output, but the fuel can easily be started and stopped.

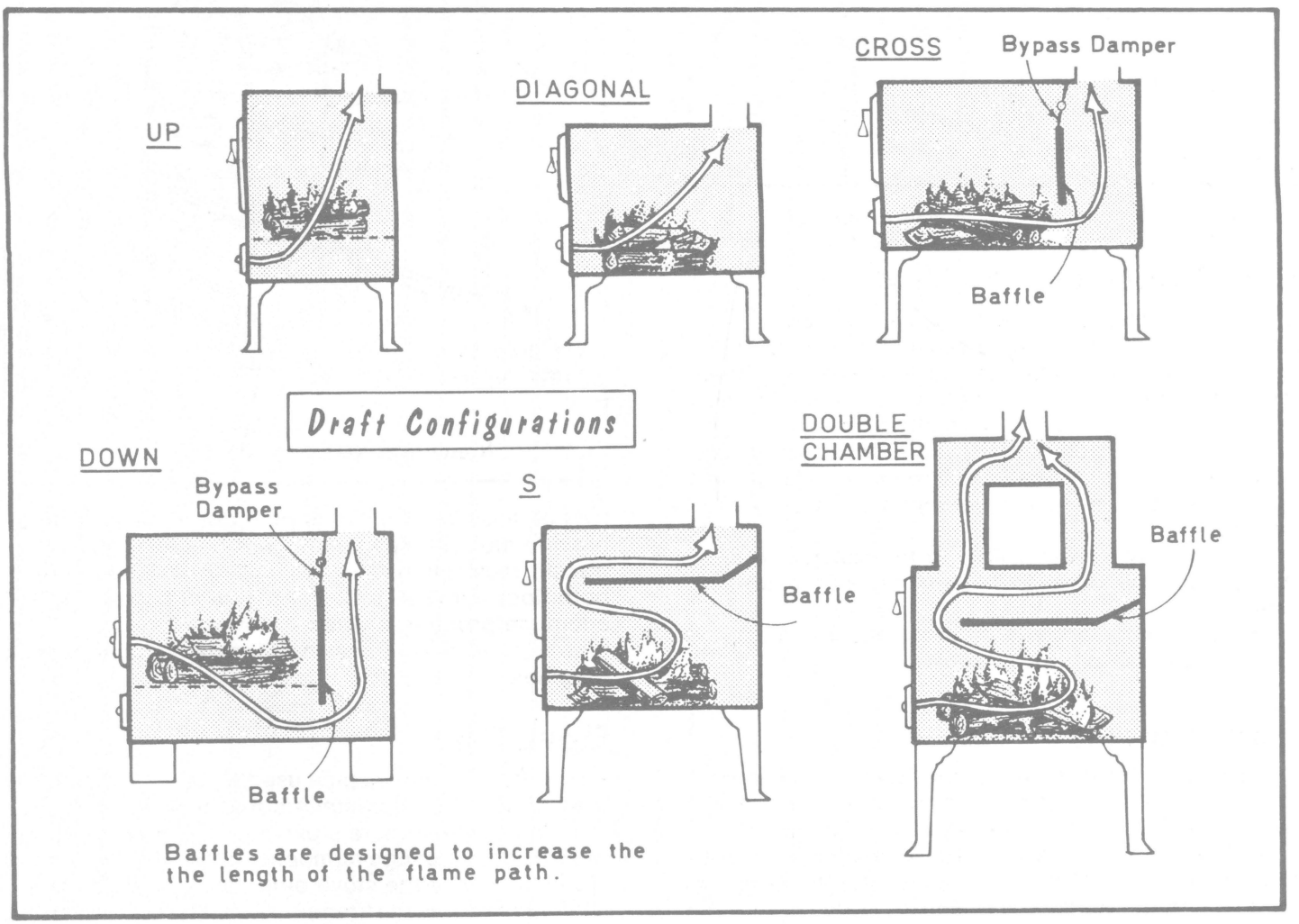
### *Combustion Efficiency*

When burning wood, combustion of the volatiles can supply a majority of heat from the burning process. Fireplaces, which are about 10 percent efficient, do not retain the gases long enough to burn them completely. To burn these gases, a long flame path heated above 1100°F is required.

Much greater efficiencies can be achieved by burning wood in a stove. The walls and top of a simple box stove can be heated sufficiently to aid in burning the volatile gases. Some stoves have a baffle adjacent to the firebox. The baffle, heated by the fire, creates a long hot flame path necessary to burn the volatile gases efficiently. Stoves with no baffle are called updraft or diagonal draft stoves. Baffles can create a downdraft, a crossdraft, or an S draft.

### Combustion Efficiency of Typical Heating Units

| Style | Efficiency |
|---|---|
| Standard fireplace | up to 10% |
| Fireplace with metal liners or tube grates | up to 20% |
| Simple updraft stove, Franklin stove | up to 30% |
| Airtight stoves | up to 45-60% |
| Ordinary furnace (burning maple at 20% moisture content | up to 50-60% |
| Gas or oil-fired furnace | up to 65-80% |



# INSTALLATION

House fires occur when stoves are improperly installed or carelessly operated. Most fires are caused when combustibles are too close to a hot stove, by escape of hot gases or flames through a crack in a chimney, by conduction of heat from a chimney into combustible materials, or by sparks or coals escaping from a stove.

Some states recommend that you consult the local building official and fire marshal and notify your insurance agent before installing a stove. The National Fire Protection Association (NFPA) has developed standards that are the basis for many local building codes. For maximum safety locate a stove or heater at least 36 inches from woodwork, other combustible materials or furniture. A stove pipe should not be closer than 18 inches to the ceiling.

***Table 3. Minimum Clearances from Combustible Walls and Ceilings****

| Type of Protection | Stove Type | | Stove Pipe |
|---|---|---|---|
| | Radiant | Circulating | |
| None | 36" | 12" | 18" |
| 1/4" Asbestos Millboard, spaced out 1" | 18" | 6" | 12" |
| 28 gage sheet metal, spaced out 1" | 12" | 4" | 9" |
| 28 gage sheet metal on 1/8" asbestos millboard, spaced out 1" | 12" | 4" | 9" |

*From National Fire Protection Association No. 89M, 1976.

## Wall Protection

The recommended clearances can be reduced considerably, if combustible walls and ceilings are protected with asbestos millboard or 28-gauge sheet metal spaced out one inch from the combustible wall. The spacers should be constructed from a non-combustible material. Provide a one-inch air gap at the bottom of the asbestos millboard or metal panel. Air circulating behind the panel will cool the panel and the wall.

Brick or stone provide little or no protection for a combustible wall because they are good conductors of heat.

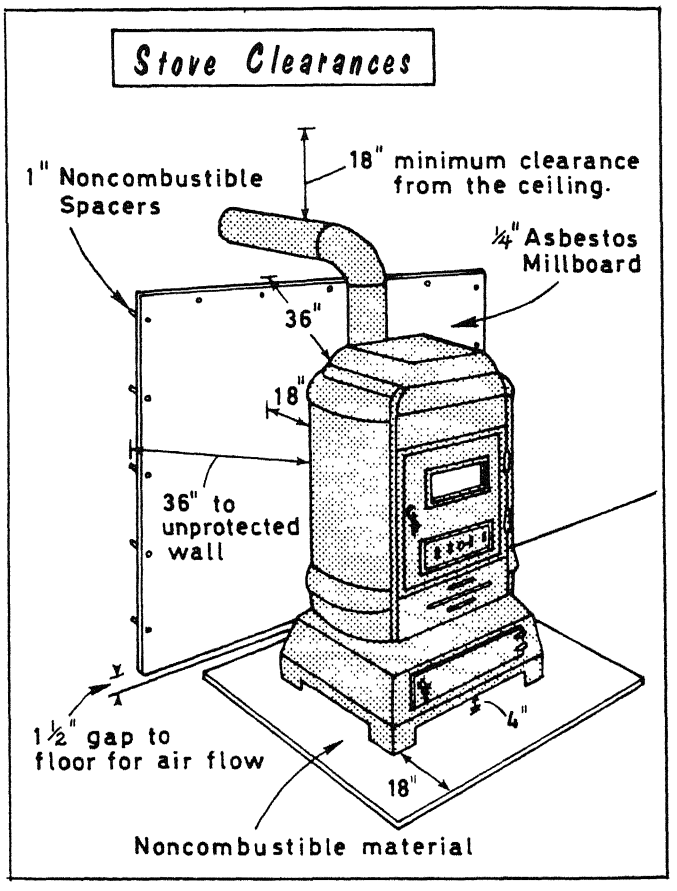
Asbestos millboard is a different material from asbestos cement board.

## Floor protection

The material used to protect the floor should extend six to 12 inches beyond the stove on three sides and 18 inches beyond the side where the wood is added.

All floors on which stoves are set, except concrete, must be protected from both heat of the fire and hot coals falling out when fuel is added. Metal with asbestos backing and asbestos millboard are non-combustible materials used for floor protection. Slate, brick, marble chips, and colored pebbles can also be used; but unless they are mortared in place with no gaps, metal or asbestos millboard must be installed between them and a wood floor. A two-inch layer of sand or ashes, or bricks laid in the bottom of the stove help prevent overheating of combustible flooring.

The air space between the bottom of the stove and the floor covering is important; stoves should be on




legs at least four inches high. Eight to ten-inch legs provide more air space, and less heat will be transferred from the stove to the floor. Be certain that both floor and wall protection extend far enough for adequate protection when a stove or Franklin type fireplace is set on a hearth or inside a stone or brick fireplace.

## Stove Pipe

The stove or smoke pipe used to connect the outlet of the firebox to the chimney is sold in 24-inch lengths. Building codes require stove pipe to be 24-gauge or thicker; higher gauge numbers indicate thinner metal. The diameter of the stove pipe used should be the same diameter as the firebox outlet. Most wood stoves

use either a six- or eight-inch smoke pipe. Using stove pipe that is smaller in diameter than the firebox outlet will reduce combustion efficiency and possibly cause improper draft.

Most stove installations should have a damper either built into the stove or in the pipe near the stove to control draft and loss of volatile gases. Check the recommendation of the stove manufacturer.

Stove pipes should be as short and as straight as possible and enter the chimney higher than the outlet of the stove's firebox. The maximum length of the pipe should be less than 10 feet.

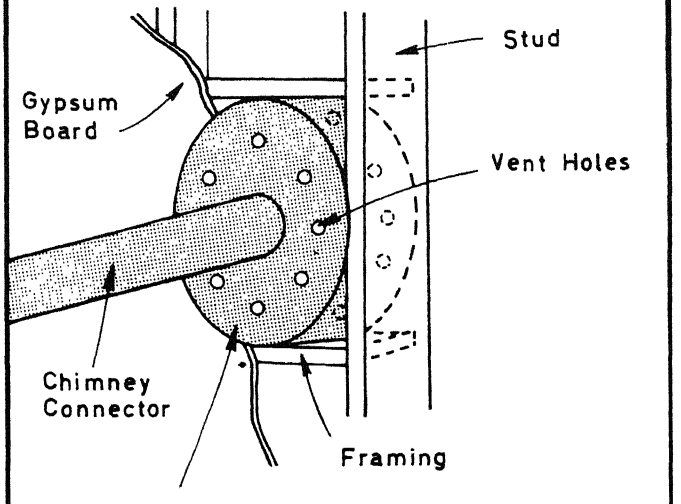
Avoid horizontal runs. Instead, use 45° angles to create an upward slope in the flue connector pipe. Try to have no more than one right angle turn between the stove and chimney.

Running a stove pipe out a window and up the outside wall of the house is a dangerous practice. Wood burners sometimes recommend long spans of single thickness stove pipe as a heating device. This idea had some merit when used with inefficient stoves where much of the heat went up the pipe. Airtight stoves, however, are more efficient, and this practice may cause rapid creosote buildup.

Long stove pipes and those with restrictions should be cleaned frequently to prevent creosote buildup and possible chimney fires.

Where a smoke pipe must pass through a wall, provide an opening with at least six inches of clearance from all wood framing and protect it with a double wall ventilated thimble. A thimble about two inches larger than the pipe is used for the installation of a flue for a gas furnace and is not adequate for a wood stove installation. The entire length of the smoke pipe must be easily inspected, firmly fastened at the joints, and kept free of all combustible materials.

A ventilated thimble permits the stove pipe to pass safely through a combustible wall.

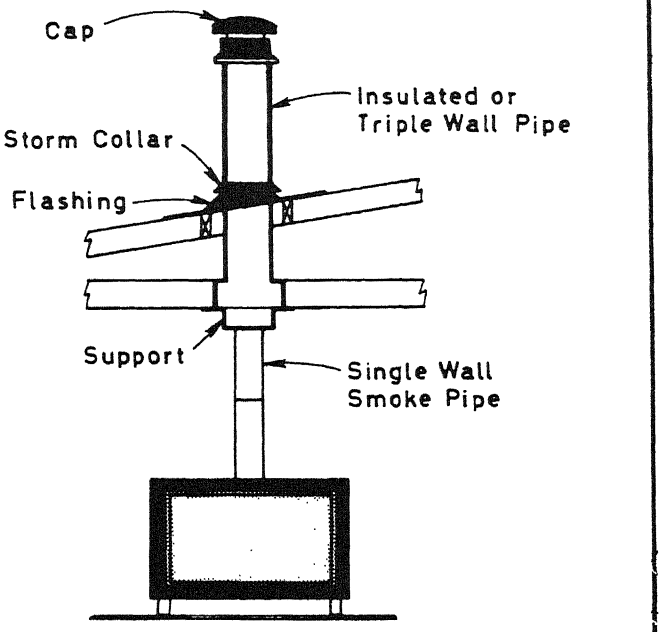



Thimble diameter should be three times the diameter of the stove pipe.

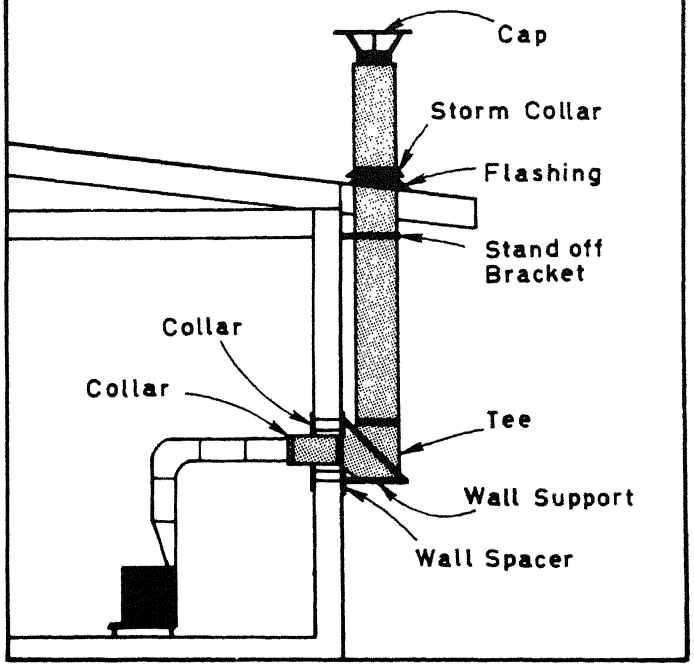
## Chimneys

The chimney has two main purposes: to create a draft and to evacuate the gases of combustion. It also discharges some of the heat generated by the fire. The higher the chimney or the larger its cross sectional area, the greater the flow capacity. However, chimney area is more important in affecting capacity than chimney height.

Prefabricated Chimney - Interior (Preferred) Installation




Prefabricated Chimney - Outside Installation

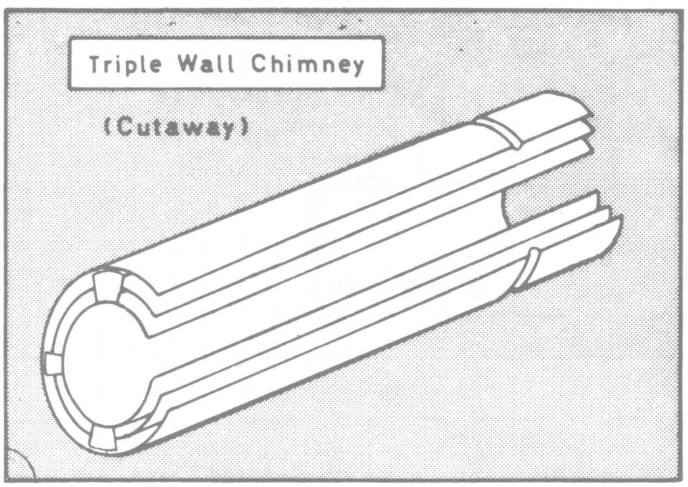


## *Prefabricated Chimneys*

Prefabricated chimneys are easier to erect than masonry ones. Tests at the National Bureau of Standards have shown that metal and masonry chimneys differ little with respect to draft when used in similar conditions. A key point is that metal prefabricated chimneys must be UL listed as ALL FUEL chimneys. Do not use the UL listed "Vent" as it is not insulated or ventilated enough for wood or coal burning. The standard sections are 18 inches and 30 inches long and are available in a variety of inside diameter sizes. The sections lock together, and no screws or special tools are needed for assembly.

There are two types of metal prefabricated chimneys: an insulated chimney and a triple wall chimney. Insulated prefabricated chimneys are made of a stainless steel outer casing, one inch of insulation, and a stainless steel inner liner.

Triple wall chimneys are constructed so that outside air passes down between the outer walls of the triple wall chimney and up along the interior wall. This movement of air cools the chimney.




## *Masonry Chimneys*

The material cost for masonry chimneys is much less per foot of length than the steel prefabricated chimneys, but much more labor is required for construction.

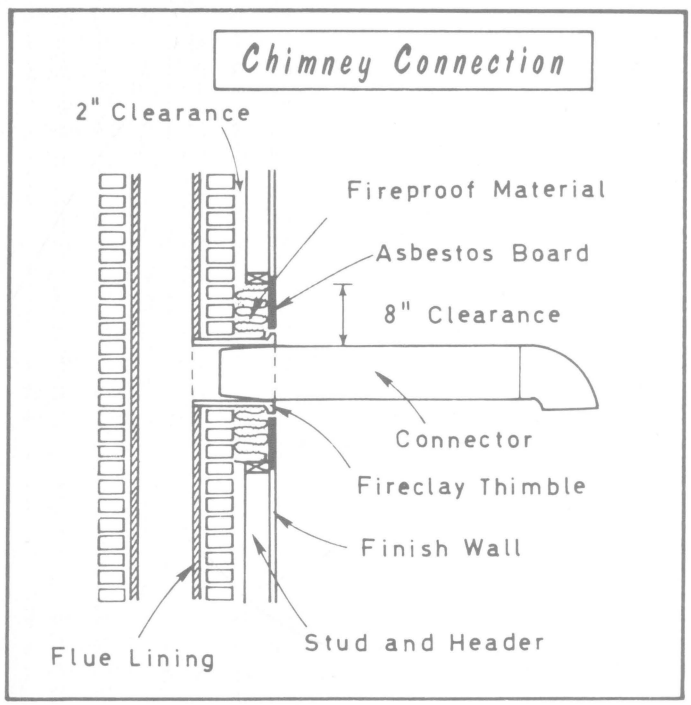
Masonry chimneys act as large heat sinks to radiate warmth into the room after the stove cools — if it is inside the house and not on an outside wall. An inside chimney absorbs heat from the fire or stove and radiates it back into the living space.

Install the stove pipe so it enters the masonry chimney horizontally. It should be installed flush with and not extend into the flue lining. The wall at the chimney connection must be protected in one of the following ways:

1. If no thimble is used the stove pipe must be securely fastened to the chimney with a high temperature cement. Combustible material within 18 inches of the pipe must be removed. For a 6-inch diameter pipe, this requires a 6-inch + 2 x 18 inches = 42-inch diameter hole in a combustible wall. The hole may be closed in or covered with non-combustible materials such as masonry, asbestos millboard, or sheet metal.

2. Use a metal thimble or a burned fire-clay thimble and surround it with at least eight inches of fireproofing material such as fiberglass insulation or brick. Cover the opening with non-combustible materials such as asbestos millboard or metal. A small gap should be left between the thimble and the covering material to allow either the house or the chimney to settle slightly and not crack the thimble. The gap can be covered with a stove pipe flange.

3. Install an insulated ALL FUEL chimney pipe as a thimble. Then only a two-inch clearance between the chimney and combustible materials is required. Cover the gap between the wall and the stove pipe with a stove pipe flange.




## *Two or More Connections to One Chimney*

One method of installation which can cause serious problems is to connect two burning devices to one flue. This method of operation is not recommended for several basic reasons: (1) when both stoves are operating the proper draft may not be present for one or both of the devices, and (2) it is possible for sparks and flue gasses to pass out into the house through one of the devices if it is not operating and the dampers are not closed, (3) when a gas or oil furnace shuts off, a small amount of unburned fuel may enter the chimney and a spark from the wood fire could ignite it and cause a small explosion, (4) a chimney fire will be more difficult to control when there is a second opening into the flue, therefore the potential fire hazard to the house and its occupants is greatly increased.

## *Chimney Caps*

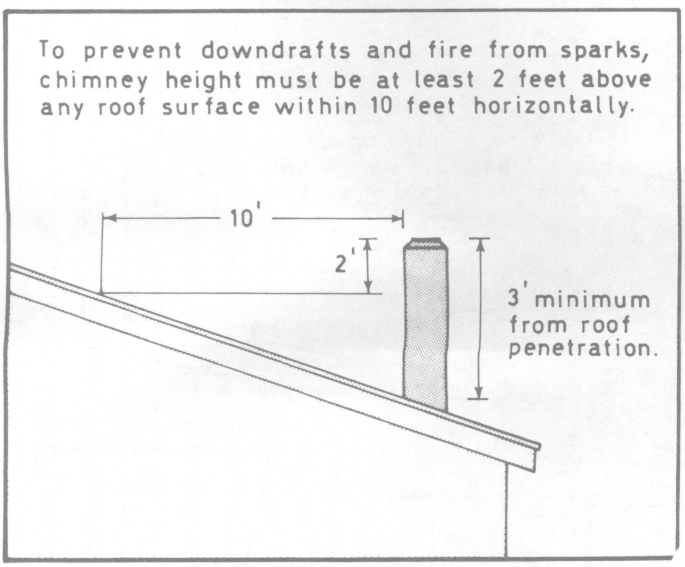
A chimney cap is sometimes used to help prevent down drafts where the top of the chimney is subject to wind turbulence caused by roof shape, trees, terrain, or other buildings, and to keep out rain and snow. Any cap adds resistance to the system and reduces the draft. Mechanical turbines, revolving ventilators and other mechanical devices are subject to failure from creosote buildup and weather. Often the disadvantages outweigh advantages and caps are not used.

If a cap is necessary, a removable flat disk cap is simple and slows gas very little.

## *Chimney Height*

A chimney should extend at least three feet above flat roofs. On pitched roofs, chimneys should be two feet higher than any point within 10 feet, to prevent down drafts caused by wind deflected from the roof.

The flue lining of a masonry chimney is extended four inches above the top course of brick or stone and the top of the chimney capped with cement mortar. The mortar is two inches thick at the outside edges of the chimney and sloped up to the flue lining to direct air currents upward at the top of the flue and to drain water from the top of the chimney.




## *Smoky Fires*

One of the most common problems of wood stove installations is smoky fires. Smoke may come into the room through the openings in the stove, or the fire may not burn properly because it lacks an adequate draft. Six main causes and cures are:

(1) **Wet wood.** Green or wet firewood causes smoke problems as much of the heat of the fire is used to dry the wood. The cure is to keep a hot fire going and to use seasoned dry wood. If green or wet wood must be burned, split it finer and mix it with dry wood. Soft wood may cause smoky fires because of the resin in the wood.

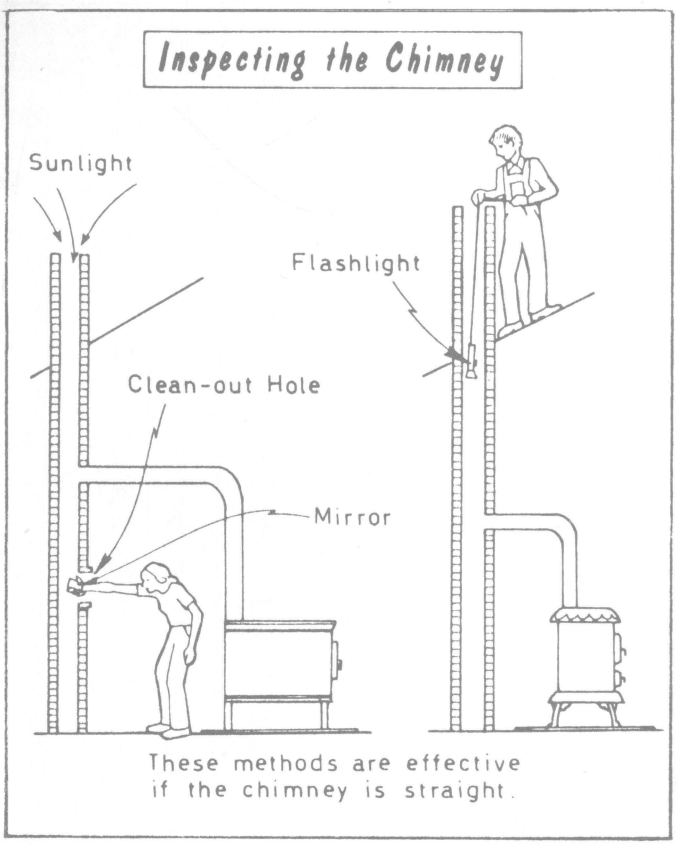
(2) **Flue too small.** The stove pipe and chimney flue must be large enough to carry the smoke and gases outside. Follow manufacturers' recommendations for stove pipe size. Do not reduce the pipe size between the stove and chimney connection. An 8"x8" or 8"x12" chimney flue is usually the minimum size for a chimney. If two wood stoves are connected to one chimney, a larger flue may be needed.

(3) **Flue too large.** Many older houses have a large central chimney with several fireplaces and flue openings. If this chimney is used with only one stove or heater, there may not be adequate draft to keep the column of smoke rising. By reducing the cross sectional area of the top of the chimney, or installing a stove pipe through the center of the flue, the smoke problem should be solved.

(4) **Obstructed flue.** Often stove pipes or flues become partially filled with soot and creosote, especially with small or slow fires. Cure this problem by checking flues and stove pipes once a month during the heating season and cleaning them when a buildup starts to occur.

(5) **Downdrafts.** Nearby trees, buildings or roof projections often cause downdrafts during windy periods. Raising the height of the chimney, removing the obstruction, or placing a cap on the chimney may correct the problem.

(6) **Lack of oxygen.** A fire needs oxygen to burn properly. In a tight, well-insulated house, infiltration has been reduced to a minimum. This lack of air can sometimes cause smoke to be pulled back into the house through an adjacent flue. Opening the basement door or a nearby window an inch or installing an air intake to the stove area will usually eliminate this problem.

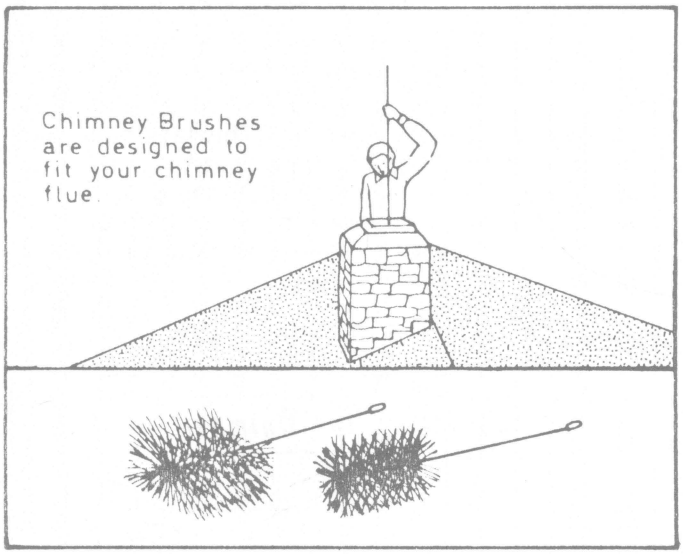


## *Chimney Inspection*

Stove pipes and chimney flues should be inspected frequently for creosote build-up, especially during the first wood burning season. One method for checking stove pipes is to tap on the pipe with a metal object. The sound will change from a metal ping to a dull thud as materials build up inside the pipe. The chimney may be inspected from the roof or, in some cases, a mirror can be used to look up through the chimney flue. If you use an air-tight stove, check the stove pipes once a month.

## *Chimney Cleaning*

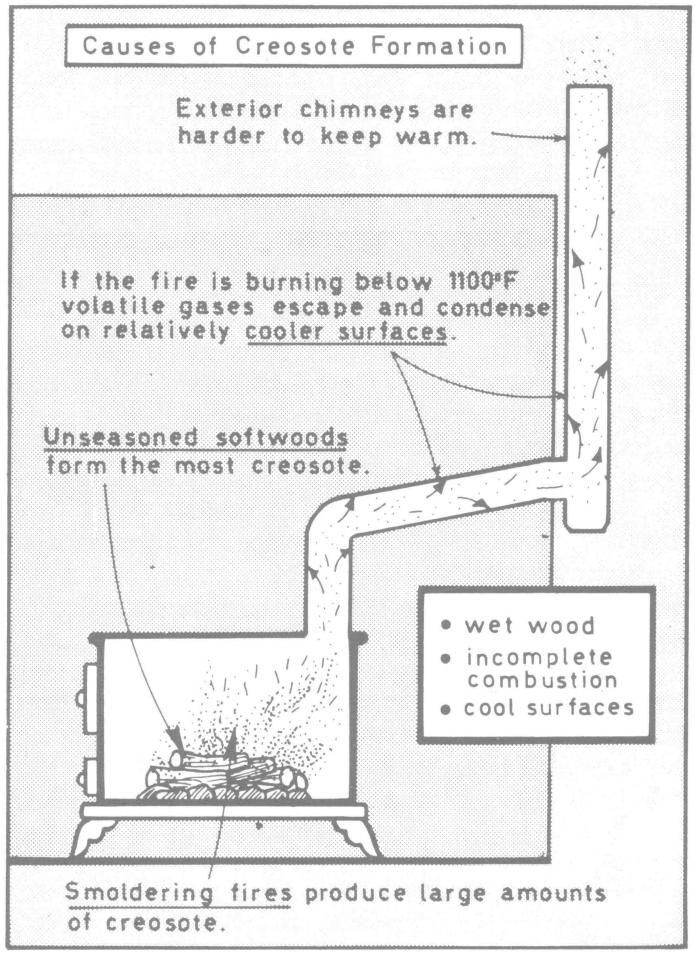
The chimney needs cleaning to prevent chimney fires and to improve the draft. How often the chimney is cleaned depends on how frequently the stove is used and how it is operated. Some people recommend cleaning the chimney after every third cord of wood is burned; some recommend once a year. Any time an inspection shows excessive soot and creosote, the chimney should be cleaned.




Chemicals, such as sodium chloride or table salt, are sometimes used as a chimney cleaner. The chemical combines with water released from a hot fire to form a weak acid that dissolves **small** amounts of creosote. There is considerable controversy as to how effective such chemicals are.

Even with the most conscientious cleaning habits, the owner of the wood stove still faces some danger of fire. The formation of creosote is a natural process resulting from the burning of wood. A properly installed wood burning stove and properly constructed chimney will withstand an occasional chimney fire. Everything possible should be done to reduce the frequency of such fires.

Chimneys are normally cleaned by mechanical means to scrape off any loose creosote build-up. Clean regularly to prevent plugging or fires. **Stiff wire chimney cleaning brushes** are used by professional chimney sweeps. These brushes are available at reasonable cost. They are constructed to match the size of the chimney flue and can be pushed through the chimney with extension rods or pipe or can be pulled with ropes on either end of the brush. In some cases a weight can be attached to the bottom of the brush which will drag the brush to the bottom of the chimney and it can be pulled up with a rope. People have pulled a bag containing wire netting weighted with chains or rocks up and down the chimney; others have used tire chains or wire netting without a bag. However, the wire brush would seem to be preferable, as it provides a uniform scrubbing of the entire surface.

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